भारतीय मानक
Indian Standard

IS 7302 : 2018
(Reaffirmed 2022)

स्वयं समाहित श्वसन तंत्र और स्वयं समाहित पानी के नीचे श्वसन तंत्र के लिये वाल्व फिटिंग — विशिष्टि

(पहला पुनरीक्षण)

Valve Fittings for Self Contained Breathing Apparatus (SCBA) and Self Contained Underwater Breathing Apparatus (SCUBA) — Specification

(First Revision)

ICS 13.240;13.340.30;97.220.40.

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली-110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.org.in www.standardsbis.in

January 2018 **Price Group 10**

Gas Cylinders Sectional Committee, MED 16

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Gas Cylinders Sectional Committee had been approved by the Mechanical Engineering Divisional Council.

This standard was first published in 1974. In this revision the following major changes have been made:

a) Scope of standard modified;
b) Terminology has been incorporated;
c) Provision of taper and parallel threads at value inlet connection has been added;
d) Outlet connection has been modified depending upon gas to be used for corresponding working pressure broadly in two categories namely; SCBA categories and SCUBA valve;
e) Type tests incorporated; and
f) Scale of sampling modified.

While implementing this standard, the manufacturer and the inspection agency shall ensure compliance with statutory regulations. It is the responsibility of the owners and the users to ensure that the cylinders are periodically tested as per norms laid down in *Gas Cylinder Rules,* 2004 as amended from time-to-time and as enforced by statutory authorities under the rules.

In the formulation this standard, considerable assistance has been derived from ISO 13341 : 2010 'Gas cylinder – Fitting of valves to gas cylinder'.

The relevant SI units and corresponding conversion factors are given below for guidance:

1 kgf/cm^2 = 98.066 5 kPa (kilopascal) = 10 m of Water column (WC)
= 0.098 066 5 MPa
= 0.980 665 bar

Pressure 1Pa (Pascal) = 1 N/m^2

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

VALVE FITTINGS FOR SELF CONTAINED BREATHING APPARATUS (SCBA) AND SELF CONTAINED UNDERWATER BREATHING APPARATUS (SCUBA) — SPECIFICATION

(First Revision)

1 SCOPE

1.1 This standard covers the requirements for design, materials, manufacture and testing of new valve fittings for use with refillable high pressure cylinders for breathing apparatus, namely Self Contained Breathing Apparatus (SCBA) and Self Contained Underwater Breathing Apparatus (SCUBA). The valves are used for breathable air, oxygen and oxygen/nitrogen mixture. Valves with both taper threads and parallel threads are covered.

1.2 This standard is not applicable to valves for industrial and medical gases, as they are separately covered in IS 3224 'Valve fittings for compressed gas cylinders excluding liquefied petroleum gas (LPG) cylinders – Specification' and valves for small refrigerants are covered in IS 12300 : 1988 'Valve fittings for refrigerant cylinders — Specification'.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1598 : 1977	Method for Izod impact test of metals (*first revision*)
1608 : 2005	Metallic materials — Tensile testing at ambient temperature (*third revision*)
3224 : 2016	Valve fittings for compressed gas cylinders excluding liquefied petroleum gas (LPG) cylinders — Specification (*fourth revision*)
IS/ISO 11114 (Part 1) : 2011	Transportable gas cylinders — Compatibility of cylinders and valve material with gas contents : Part 1 Metallic materials

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply:

3.1 Bottom Spindle/Seat Insert Holder/Seat Plug/ Lower Plug — Lower member of a two-piece spindle actuated by the top spindle.

3.2 Burst Test Pressure (P_{vbt}) — Minimum pressure applied to a valve during hydraulic burst pressure test.

3.3 Cylinder Neck — The part of the cylinder that has the threaded connection for the valve stem (inlet).

3.4 Cylinder Valve — Mechanical device attached to a compressed gas cylinder that permits flow into or out of the cylinder when in the open position and prevents flow when in the closed position.

3.5 Endurance Torque (T_e) — Closing torque applied during the endurance test.

3.6 Endurance Torque at Start ($T_{e,Start}$) — Endurance torque to be applied at the beginning of the endurance test.

3.7 Endurance Torque at End ($T_{e,End}$) — Endurance torque measured at the end of the endurance test to achieve internal leak tightness.

3.8 Excess Flow Valve — Valve which automatically shuts off, or limits the gas flow when the flow exceeds a set design value.

3.9 External Leak Tightness — Leak tightness to atmosphere (leakage in and/or leakage out) when the valve is open and the outlet is sealed.

3.10 Failure Torque (T_f) — Opening or closing torque (whichever is the lower value) applied to the valve operating device to obtain mechanical failure of the valve operating mechanism and/or valve operating device.

3.11 Filling Pressure — The settled pressure at a uniform temperature of 15 °C at full gas content.

3.12 Flow Restrictor — Device designed to limit the maximum flow through the valve outlet.

3.13 Full Flow — Valve's open position when maximum flow capacity is achieved.

3.14 Gland Nut /Packing Nut/Bonnet — Threaded valve component tightened onto or into the valve body to retain and compress the packing, diaphragm(s) or other sealing member(s).

3.15 Hand Wheel — Manually operated device attached to the valve spindle used to open and close the valve.

3.16 Hand Wheel Diameter — Nominal value of twice the largest radius from the centre of the hand wheel.

3.17 Internal Leak Tightness — Leak tightness across the valve seat (leakage in and/or leakage out), when the valve is closed.

3.18 Leak — An unintended flow of gas or liquid in excess of 6 cm^3/h corrected to NTP.

3.19 Minimum Closing Torque (T_c) — Torque necessary to be applied to a valve operating device of a newly manufactured cylinder valve to obtain internal leak tightness at the valve test pressure (P_{vt}) at room temperature.

3.20 Normalizing — A process in which steel is heated to a temperature above its upper critical point (Ac3) (also known as solution temperature) and subsequently cooled in still air.

3.21 NTP — Normal temperature and pressure [20.0°C (293.15 K) and 1.013 bar absolute (0.913 MPa absolute)]

3.22 O-ring — A torus, a circle of rubber or plastic with round cross section which provides effective sealing against pressure.

3.23 Outlet Dust Cap/Plug — Cap or plug that only serves as a protective covering for the valve outlet to minimize contamination from external sources.

3.24 Outlet Seal Cap/Plug — Cap or plug that serves as a protective covering for the valve outlet against contamination from external sources and also serves as a pressure barrier to prevent leakage through the valve outlet.

3.25 Over Torque (T_o) — Opening or closing torque (whichever is the lower value) applied to valve operating device to determine the level of torque, which the valve operating mechanism can tolerate and remains operatable.

3.26 Packing — Non-metallic material installed around the spindle in a packed valve, when compressed creates a seal against leakage past the spindle.

3.27 Prototype Test /Design Qualification Test/Type Test — A test or series of tests carried out for approval of a valve design to the requirements of the product specification.

3.28 SCBA — Self Contained Breathing Apparatus.

3.29 SCUBA — Self Contained Underwater Breathing Apparatus.

3.30 Seat Insert — Material contained in or on the bottom spindle (sometimes on a one-piece spindle) usually made of a soft material to facilitate sealing against the valve body seat.

3.31 Shutoff /Closure — Position of the valve when the valve spindle is in contact with the valve body seat and no-flow condition of the valve.

3.32 Spindle — The element(s) of the valve which, when operated, directly or indirectly actuates the sealing member (seal) to 'open' or 'closed' position.

3.33 Stress Relieving — A process to reduce internal stresses in a metal/forging/component by heating it to a suitable temperature for a stipulated period of time.

3.34 Tang — Member or extension projecting from either the lower end of a top spindle or the upper end of a bottom spindle, mechanically attached or integral to the spindle, through which torque is transmitted in a two-piece spindle.

3.35 Thread Sealant — Material applied to a taper thread to effect a gas tight joint. It fills the cavity remaining in the helix of mating threads.

3.36 Toggle — Usually a handle (lever) attached to the valve by pin to rotate the operating mechanism of the valve.

3.37 Top spindle — Upper member of a two-piece spindle that when operated causes the bottom spindle to move.

3.38 Valve Body— The major valve component which includes an inlet and an outlet and where applicable, a boss for the pressure relief device/major portion of the valve (normally one piece) that contains the orifice, valve body seat, an inlet and outlet connections, and is machined to accept the component parts to create a valve assembly.

3.39 Valve Body Seat/Sealing Face — Sealing surface surrounding the orifice of the valve body.

3.40 Valve Design — Classification of valves with regard to the valve operating mechanism.

3.41 Valve Filling Connection — Connection on the valve used to fill the cylinder.

NOTE — For most valves this connection is also used for filling the cylinder.

3.42 Valve Inlet Connection — Connection on the cylinder valve which connects the valve to the cylinder.

3.43 Valve Operating Device — Component which actuates the valve operating mechanism.

Example — Hand wheel, key, knob, actuator, toggle or lever.

3.44 Valve Operating Mechanism — Mechanism which closes and opens the valve orifice and which includes the internal and external sealing systems.

Example — A threaded valve spindle which, when rotated, raises and lowers seal.

3.45 Valve Outlet Connection — Connection on the cylinder valve used to discharge the cylinder.

NOTE — For most valves this connection is also used for filling the cylinder.

3.46 Valve Test Pressure (P_{vt}) — Minimum pressure applied to valve during endurance test and oxygen pressure surge test.

3.47 Working Pressure (P_w) — Settled pressure (filling pressure) of a compressed gas (for permanent gas) at a uniform reference temperature of 15°C in a full gas cylinder for which the valve is intended.

4 MATERIAL

4.1 All materials used in the manufacture of valves, their fittings and protective coatings (if any) shall be compatible with the gas to be contained in the cylinder and with the material of the cylinder [*see* IS/ISO 11114 (Part 1)].

4.2 Valve body shall be forged from wrought or extruded section of brass rod and shall comply with **4.2.1** and **4.2.2**. Composition of valve body material shall be as agreed to between the purchaser and the manufacturer subject to approval of statutory authority.

4.2.1 *Tensile Strength and Elongation*

The tensile strength and elongation of the material of the valve body forging determined according to IS 1608 shall be respectively at least 392 MPa (40 kgf/mm^2) and 18 percent measured on a gauge length 5.65 $\sqrt{S_o}$, where S_o is the original area of cross-section.

4.2.2 *Impact Strength*

The Izod impact strength of valve body forging determined according to IS 1598, shall not be less than 21.5 J (2.2 kg.m) for brass.

4.2.3 *Test Samples*

Test samples for tensile and Izod impact tests shall, wherever practicable, be drawn from a valve body blank; where this is not practicable, the test samples shall be made from same raw material (wrought or extruded section), giving the same outside shape as the valve body blanks it represents. The scale of sampling and criteria for conformity shall be in accordance with the requirements of **9.7**.

4.3 Other Brass Components

Other components of the valves shall be as agreed to between the purchaser and the manufacturer.

4.4 Protective Finishes

Protective finish and coated components if used shall not adversely affect the performance of the valve. Plating shall not be carried out on gas wetted areas to avoid the flaking or particle generation and on inlet and outlet threads.

5 VALVE DESIGN REQUIREMENT

5.1 General Criteria

5.1.1 Valves shall be wheel/knob operated soft seating type, preferably in O-ring seal design or pressure seal design (*see* Fig. 1 and Fig. 2). The diameter of wheel / knob shall not exceed 65 mm.

5.1.2 Valve shall be designed to operate satisfactorily and be leak tight over a range of service temperatures, from –20 °C to + 65 °C.

5.1.3 Working pressure (P_w) of the valve shall be filling pressure/settled pressure at 15°C, design working pressure will not exceed 350 Bar.

5.1.4 The minimum finished wall thickness at any point of the valve shall not be less than 2.5 mm. However, this requirement shall be relaxed in case of sections not susceptible to tamper damage or rupture during use or where any damage to the section will not affect the sealing off of the valve.

5.1.5 The component and parts of the valve of same design of a manufacturer shall be interchangeable.

5.1.6 Valves shall be fitted with limiter type of excess flow valve, shall be mounted inside cylinder, the cut off position, flow characteristic etc, will be as agreed to between the purchaser and the manufacturer. The main body of the excess flow valve shall be manufactured from extruded brass material.

5.1.7 Valves may be provided with the provision to fit pressure gauge (for user to monitor the pressure inside the cylinder).

5.2 Valve Dimensions

5.2.1 The valve dimensions and connecting bore diameters shall be determined by the application of the gas, the rate of flow required, the gas service pressure, the required mechanical strength of the connections and any other safety aspects subject to agreement between the purchaser and the manufacturer. Unspecified valve body dimension unspecified chamfer/ radius at sharp will be as per good engineering practice unless specified by the purchaser.

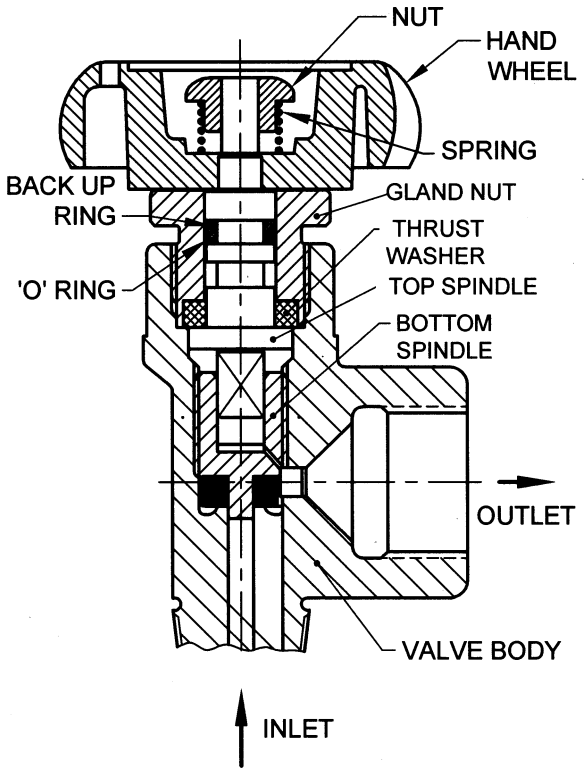


FIG. 1 ILLUSTRATION OF PRESSURE SEAL VALVE, NON METALIC SEAL (WHEEL OPERATED)

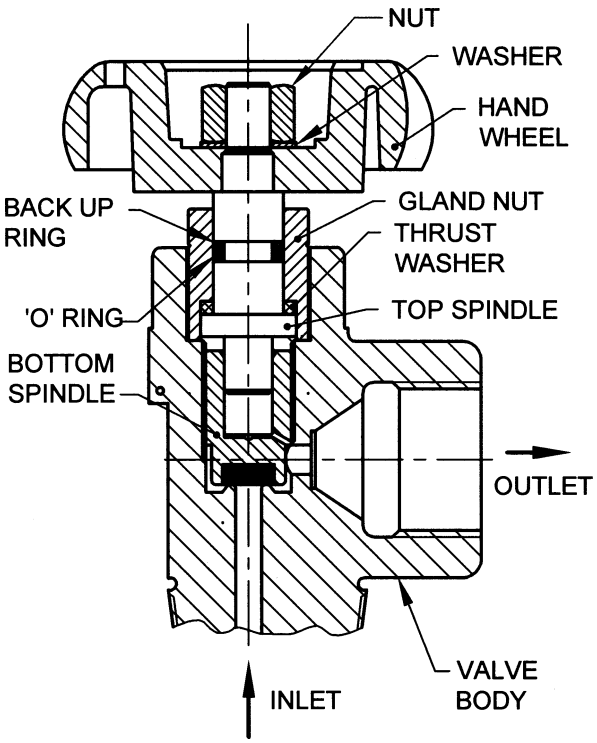


FIG. 2 ILLUSTRATION O-RING GLAND SEAL VALVE, NON METALIC SEAL (WHEEL OPERATED)

5.2.2 Valve inlet dimension shall be as per **6**.

5.2.3 Valve outlet dimension shall be as per **7**.

5.3 Valve Operating Mechanism

The valve operating mechanism shall fulfil following requirements:

5.3.1 It shall withstand over torque (T_o) without damage or failure of any component of the valve operating mechanism and/or valve operating device. Both (T_o) and (T_f) shall not be less than the values given in Table 4. Mechanical failure shall occur before unscrewing of the valve operating mechanism and shall be in a manner that will not result in ejection of the valve components. The excessive torque test is given in **8.6.4**.

5.3.2 It shall function satisfactorily after 2 000 opening and closing cycles with endurance torque (T_e) at valve test pressure (P_{vt}) without replacement of the sealing system. T_e is given in Table 4. After the endurance test and the subsequent leak tightness tests have been performed a visual examination shall be carried out to ensure that no components are displaced non-functional (for example broken) or missing. The endurance test is given in **8.8**. The visual examination is given in **8.9**.

5.4 Valve Operating Device

5.4.1 Valve operating mechanism shall close the valve in clock-wise direction when viewed from the spindle end.

5.4.2 Hand wheel / knob shall be clearly marked with 'Open' or 'Closed' condition.

5.4.3 The valve operating device shall be designed to permit the closure of the valve after exposure to a flame. Although the valve operating device may be damaged during the test, it shall still be possible to be closed by hand. The flame impingement test as per **8.10**.

5.5 SAFETY

5.5.1 The valve stem shall be of sufficient strength to withstand valving torque. The test for valving torque as per **8.6.3**.

5.5.2 Cylinder valve shall be capable to withstand valve impact test as per **8.6.2**.

5.6 Leakage

5.6.1 The internal leakage shall not exceed 6 cm^3/h corrected to NTP over the range of pressures and temperatures specified in Table 3 and Table 1 respectively, with the operating mechanism in the 'fully closed' position (*see* **8.7.2**).

5.6.2 The external leakage shall not exceed 6 cm^3/h corrected to NTP over the range of pressures and temperatures specified in Table 3 and Table 1 respectively, with the operating mechanism in different positions, if applicable between and including the 'fully open' and the 'closed' positions (*see* **8.7.3**).

NOTE — The leakage of 6 cm^3/h is approximately 4 bubbles of 3.5 mm diameter per minute.

6 INLET CONNECTIONS

The valve inlet connection shall be provided with either taper thread or parallel thread.

6.1 Taper Screw Threads

Taper screw threads shall be any one of the types specified below:

Type 1 thread — Size 1
Type 1 thread — Size 2
Type 2 thread — Size 1
Type 2 thread — Size 2
Type 4 thread — Size 1, Size 2
} (*see* IS 3224)

6.2 Parallel thread on the valve stem with cylinder neck dimension are given in **6.2.1** and **6.2.2**.

6.2.1 Inlet connection with parallel thread M 18 × 1.5 (*see* Fig. 3).

6.2.2 Inlet connection with parallel thread M 25 × 2 (*see* Fig. 4).

7 OUTLET CONNECTIONS

7.1 SCBA Valves

There are broadly six types of outlet connections for SCBA depending on the gas to be used and on the working pressure.

7.1.1 Thread connection for breathable air up to 250 bar (*see* Fig. 5).

7.1.2 Thread connection for breathable air from 250 to 350 bar (*see* Fig. 6).

7.1.3 Thread connection for oxygen up to 250 bar (*see* Fig. 7).

7.1.4 Thread connection for oxygen from 250 bar to 350 bar (*see* Fig. 8).

7.1.5 Thread connection for oxygen / nitrogen up to 250 bar (*see* Fig. 9).

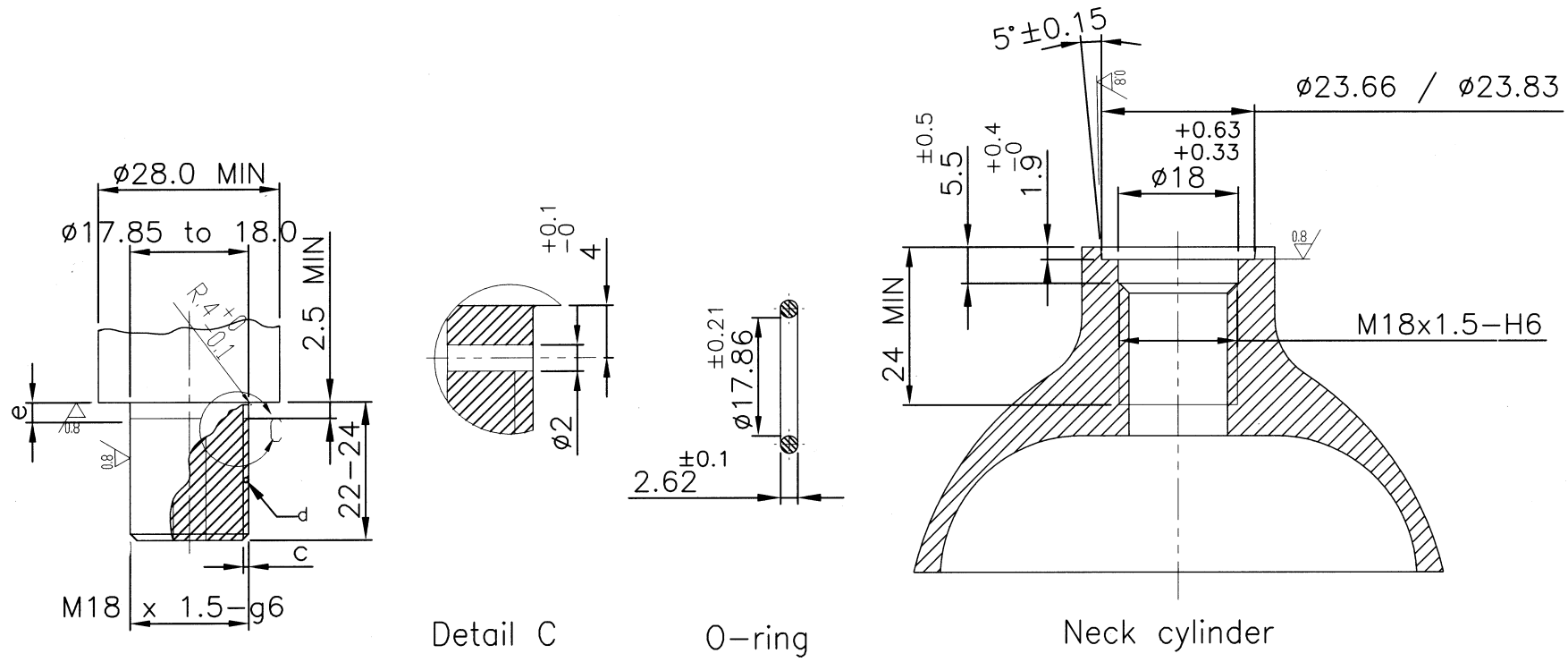
7.1.6 Thread connection for oxygen /nitrogen from 250 bar to 350 bar (*see* Fig. 10).

7.2 SCUBA Valves

There are broadly two types of outlet connection of SCUBA valves.

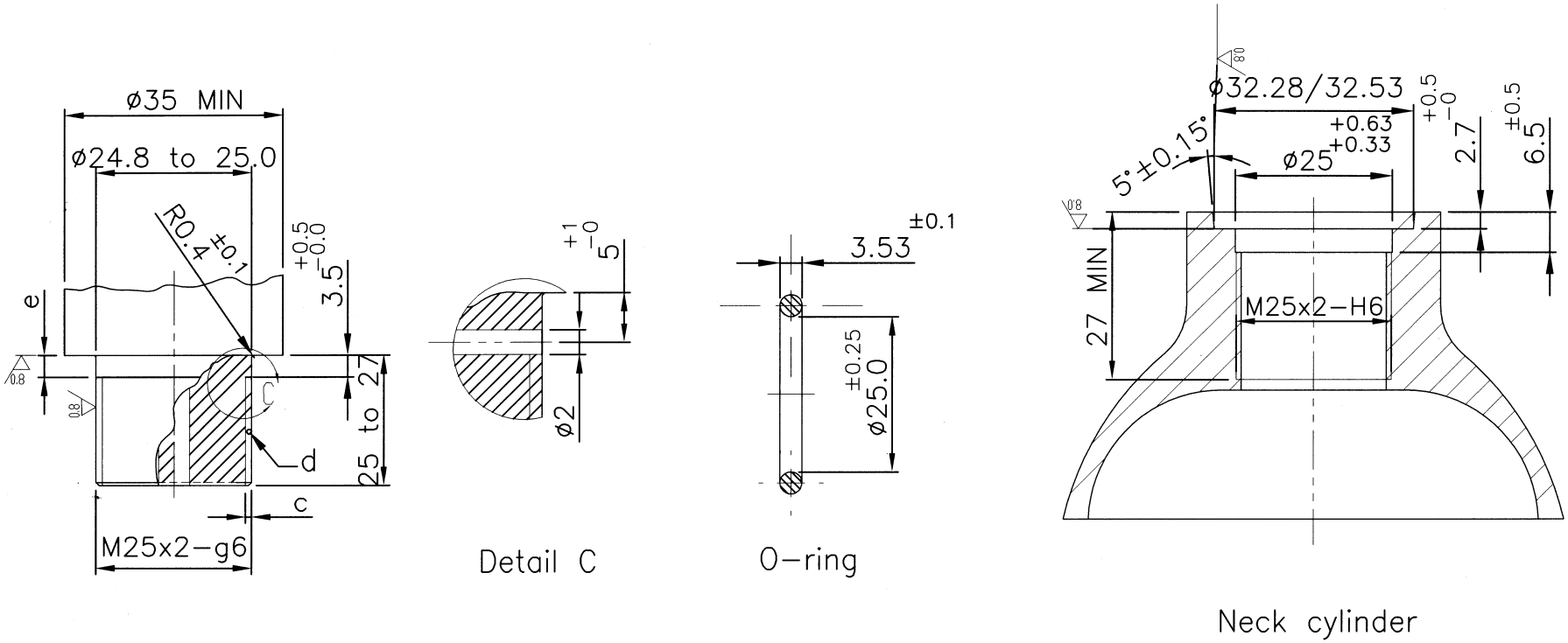
7.2.1 Threaded type outlet up to maximum working pressure of 232 bar (*see* Fig. 11).

7.2.2 Threaded type outlet up to maximum working pressure of 300 bar (*see* Fig. 12).



All dimensions in millimetres.

FIG. 3 INLET WITH PARALLEL THREAD M18 × 1.5



c) Maximum groove depth 1.0 below root diameter of thread

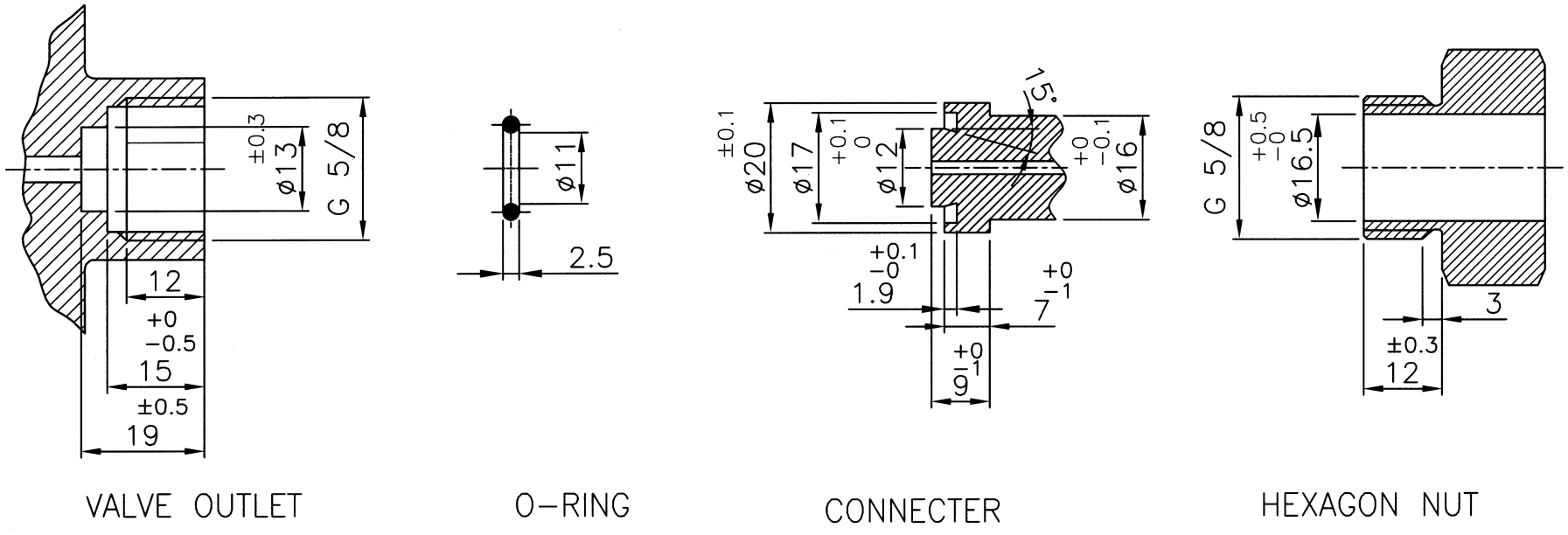
d) Venting groove. Width of groove: 2 max. runout at choice of manufacture

Note 1) Thread runout to be compatible with dimension of neck cylinder

Note 2) The venting hole shall be replaced by a venting groove if the valve is equipped with a pressure limiting device

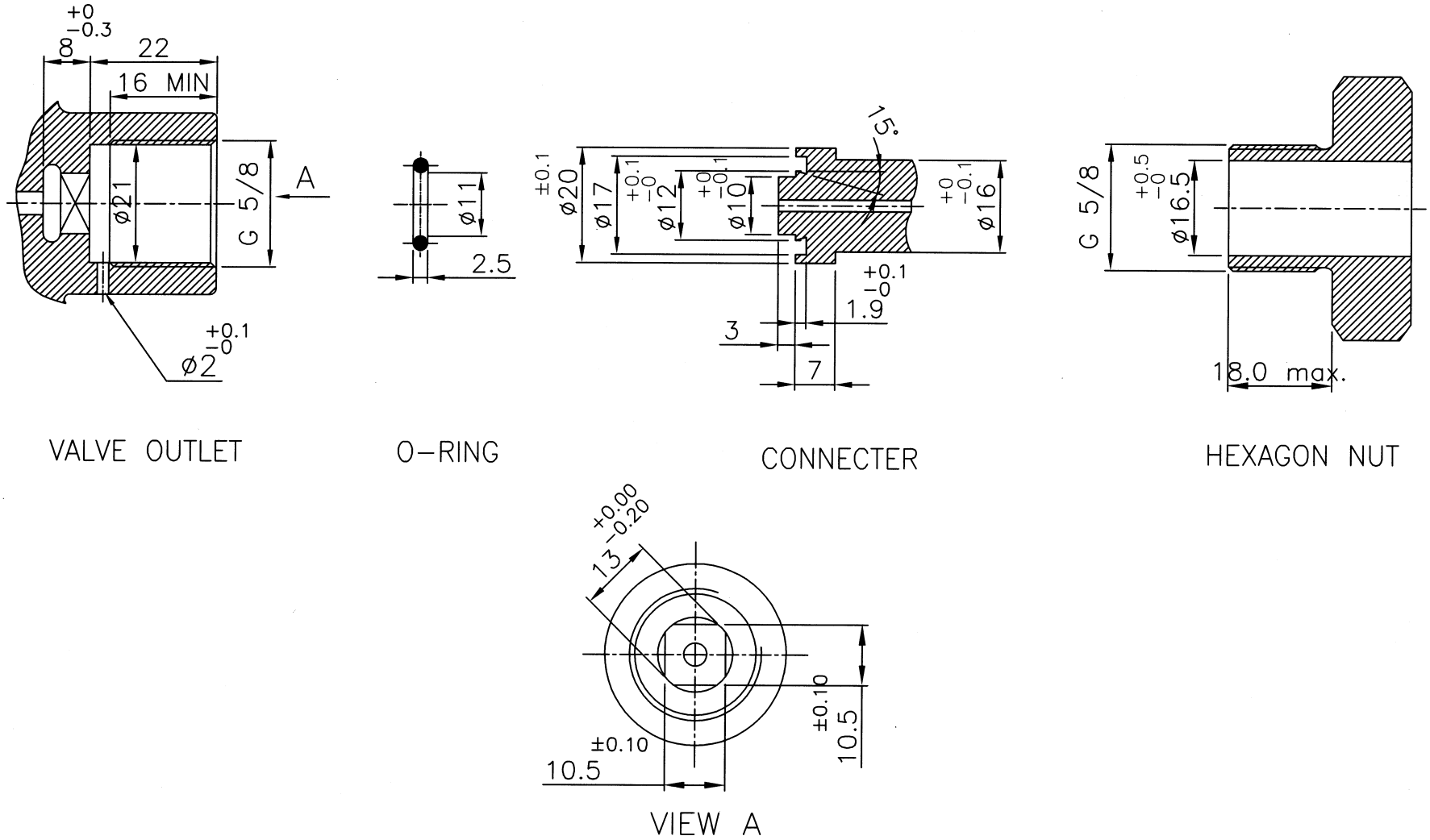
All dimensions in millimetres.

FIG. 4 INLET WITH PARALLEL THREAD M25 × 2



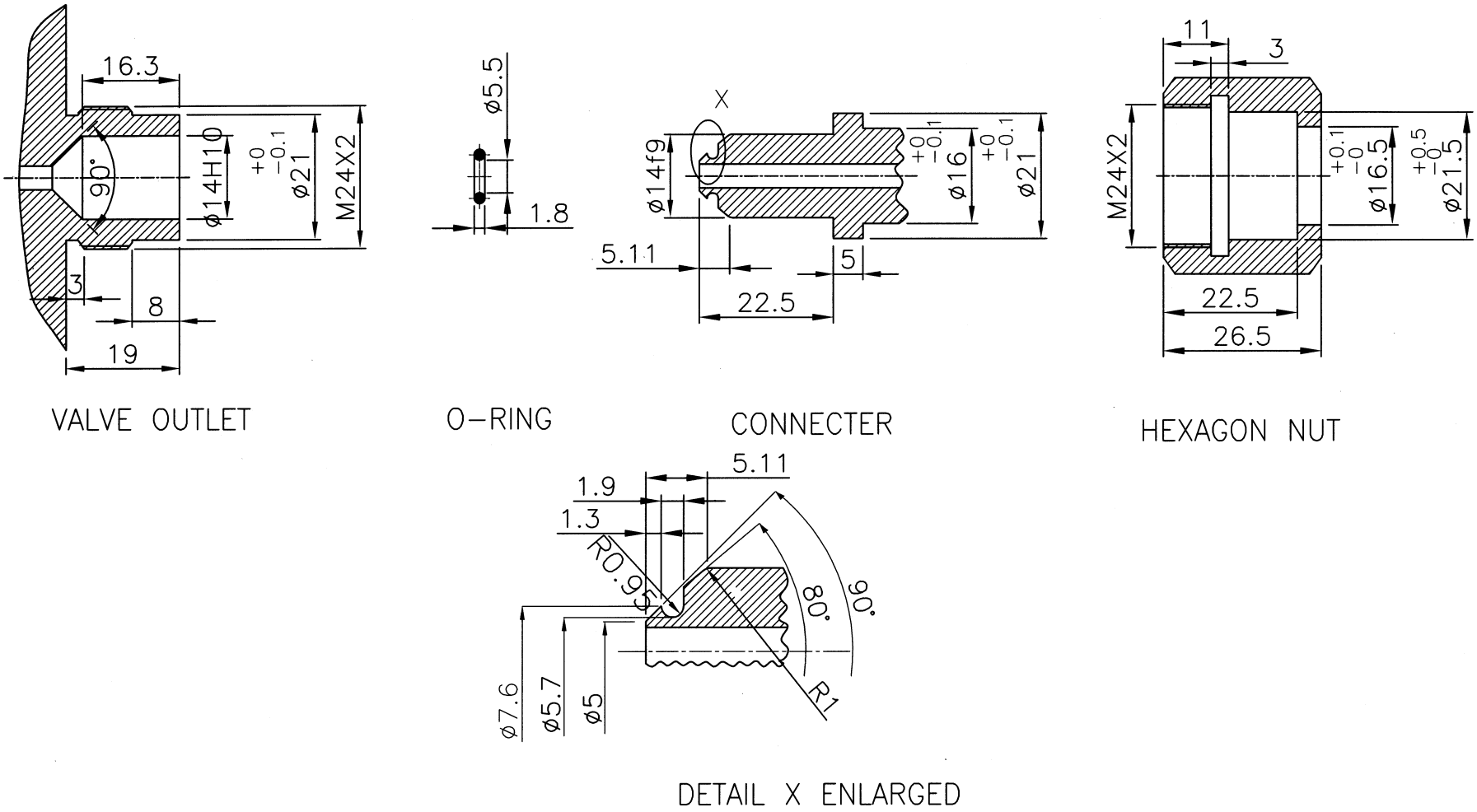
All dimensions in millimetres.

FIG. 5 CONNECTION FOR BREATHABLE AIR UPTO 250 BAR



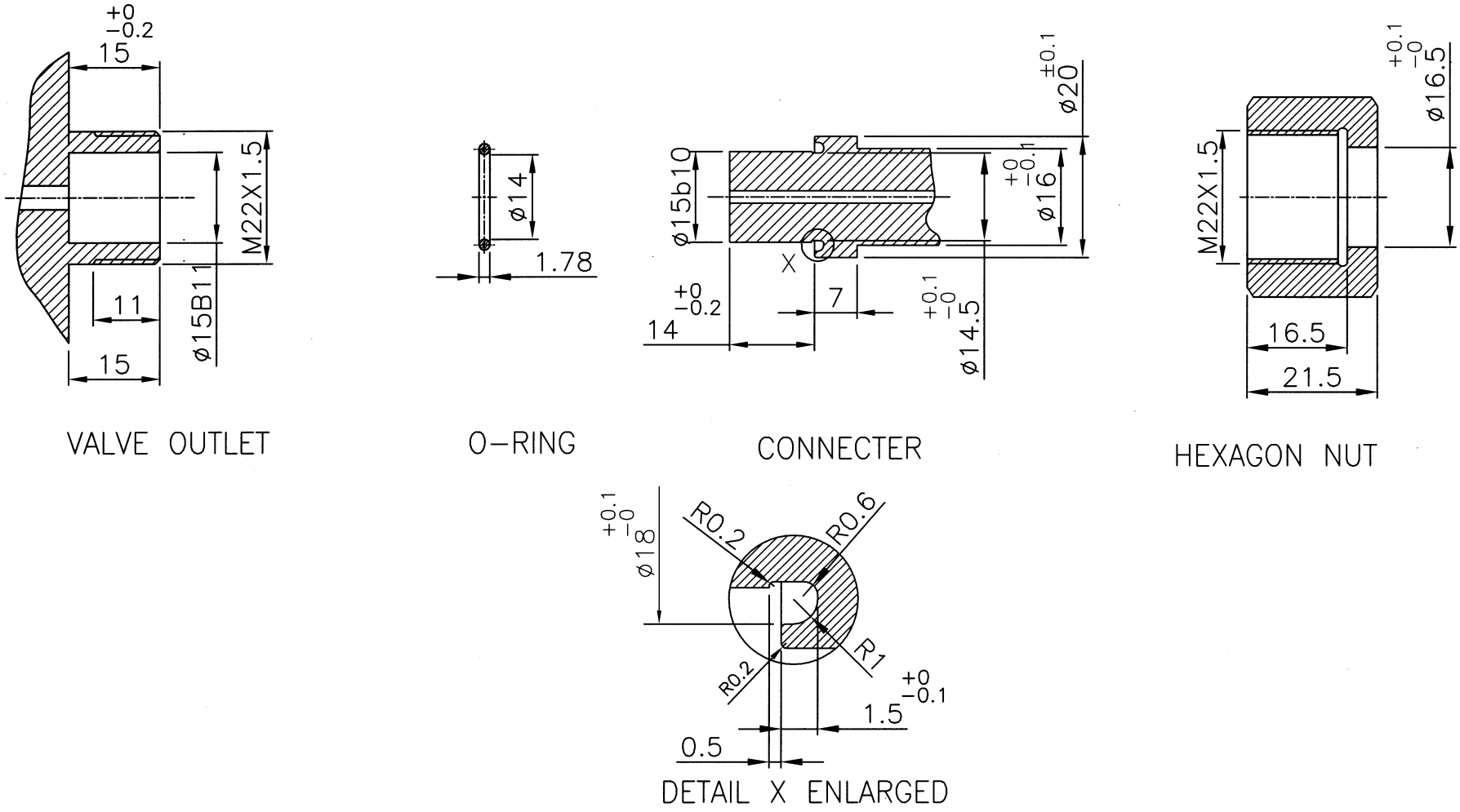
All dimensions in millimetres.

FIG. 6 OUTLET CONNECTION FOR BREATHABLE AIR FROM 250 TO 350 BAR



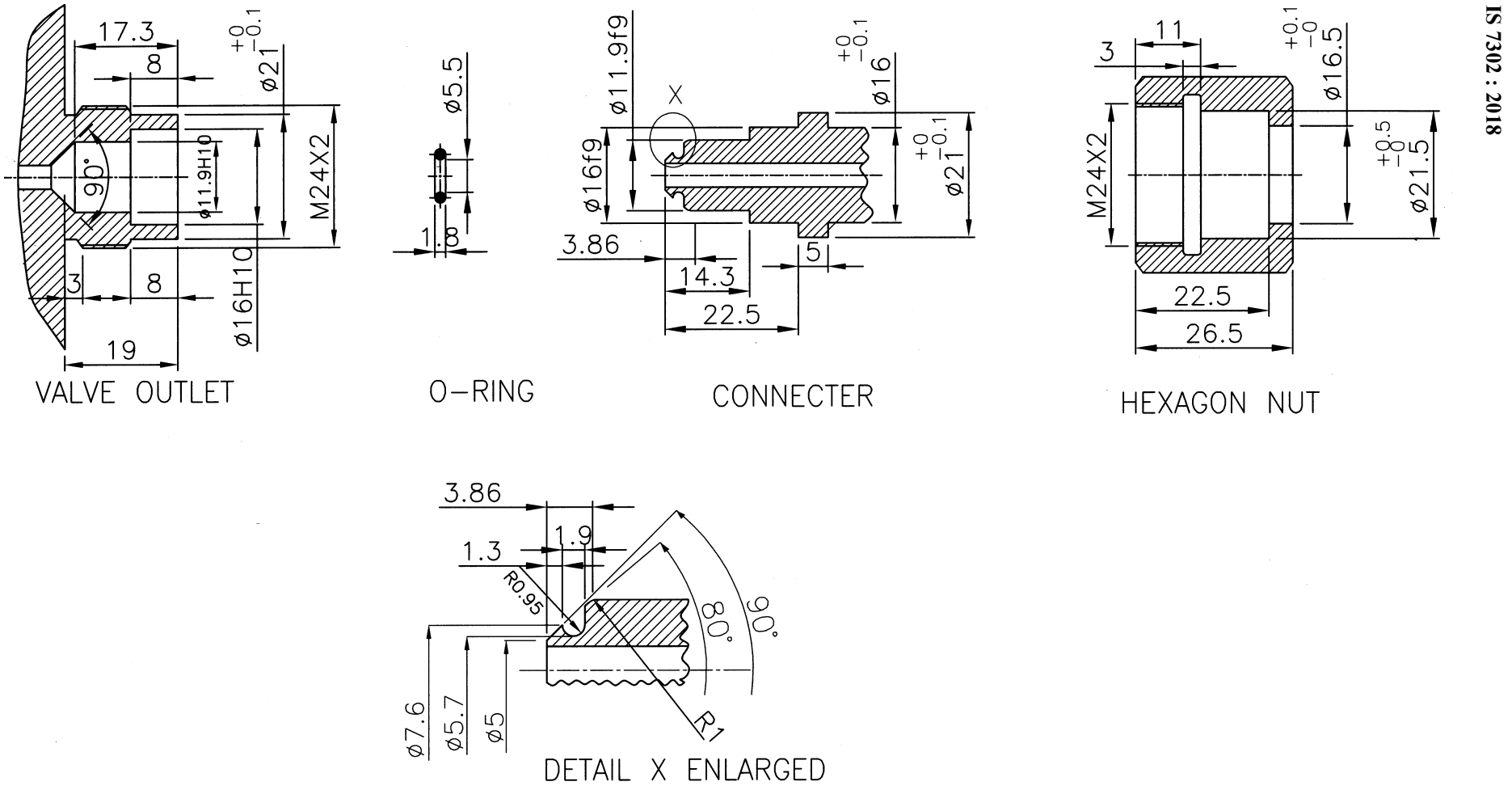
All dimensions in millimetres.

FIG. 7 OUTLET CONNECTION FOR OXYGEN UPTO 250 BAR



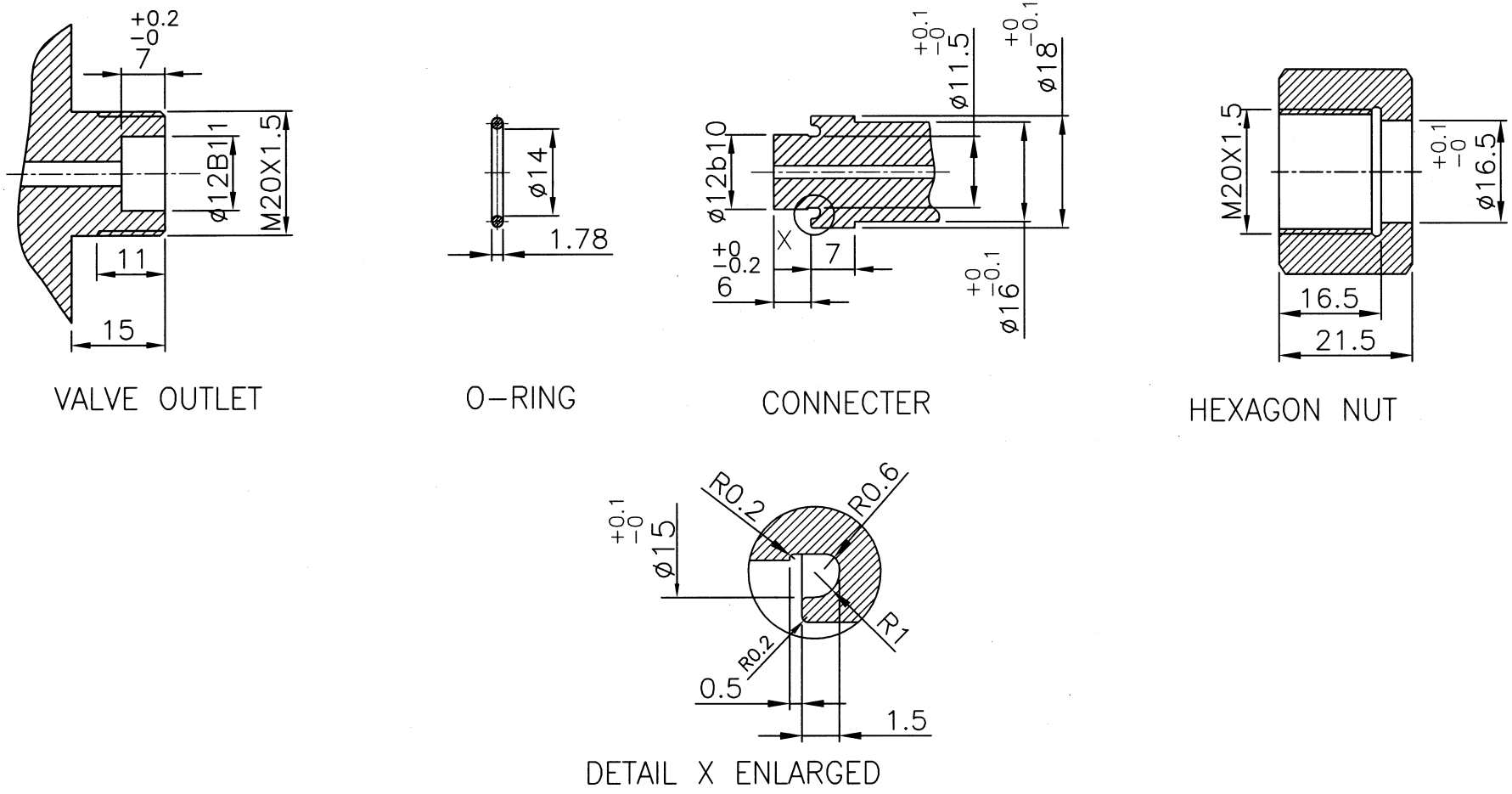
All dimensions in millimetres.

FIG. 8 OUTLET CONNECTION FOR OXYGEN FROM 250 TO 350 BAR



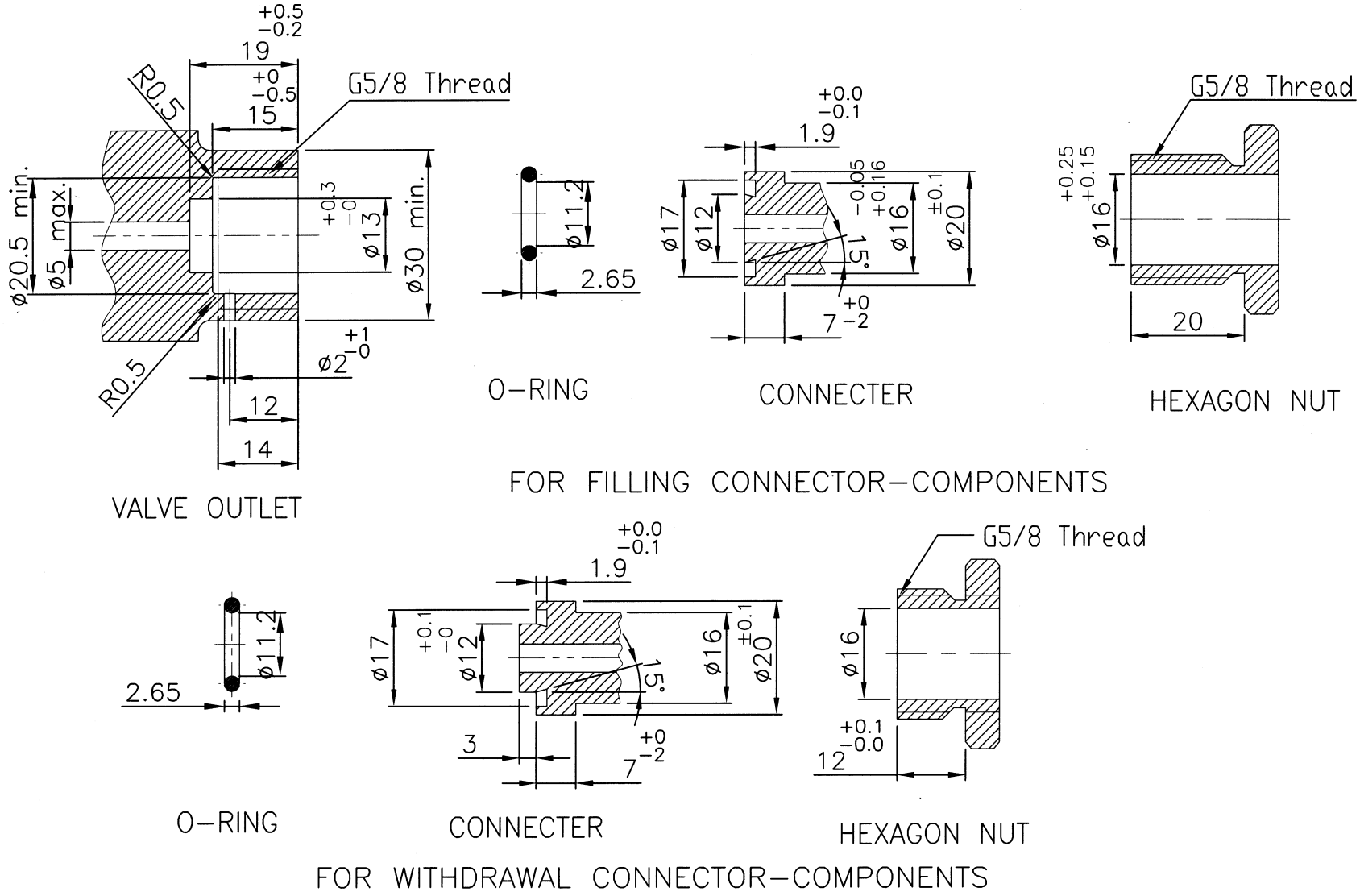
All dimensions in millimetres.

FIG. 9 OUTLET CONNECTION FOR OXYGEN/NITROGEN UPTO 250 BAR



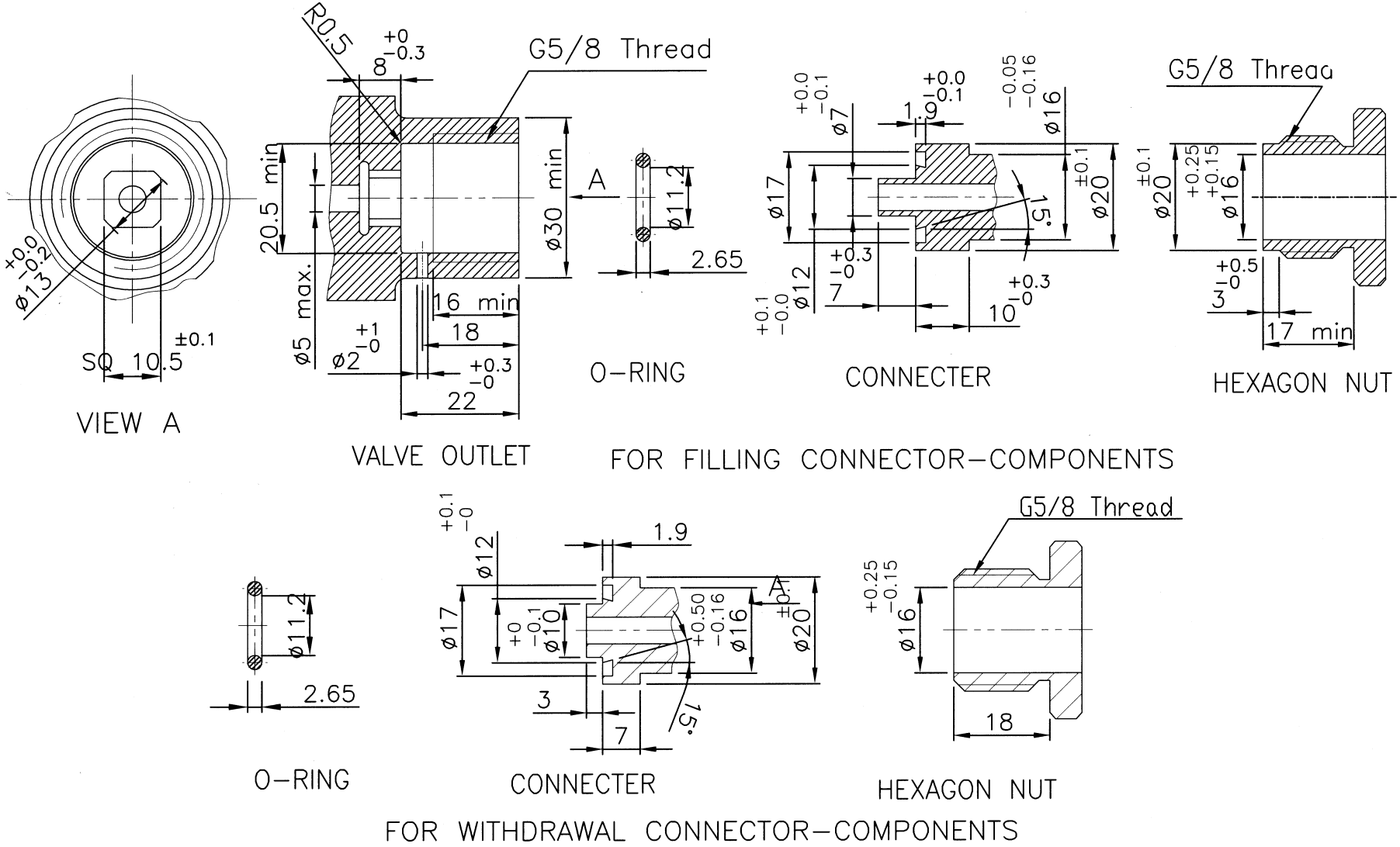
All dimensions in millimetres.

FIG. 10 OUTLET CONNECTION FOR OXYGEN/NITROGEN UPTO 250 TO 350 BAR



All dimensions in millimetres.

FIG. 11 OUTLET CONNECTION FOR OXYGEN/NITROGEN FROM 250 TO 350 BAR



All dimensions in millimetres.

FIG. 12 OUTLET CONNECTION THREADED TYPE OUTLET UPTO MAXIMUM WORKING PRESSURE OF 300 BAR

8 VALVE DESIGN QUALIFICATION TESTS (TYPE TESTS)

8.1 To comply with this standard cylinder valves shall be type tested. A type test is valid for a given valve design. Unless otherwise stated, all tests shall be performed at room temperature. The number of samples required for type testing a valve design is given in Table 1. Material variants within a valve design, for example, for reasons of compatibility between gas and non-metallic material require repetition of only the relevant parts of the type test, using a reduced number of test samples for the tightness and endurance test. Additional test samples might be required for changes or for material variants within the valve family (*see* Table 1). Examples of components which might constitute material variants include:

a) O-ring;
b) Back-up ring;
c) Packing;
d) Seat insert;
e) Lubricant;
f) Spring; and
g) Thrust washer.

8.2 Some changes within the valve design qualified to this standard which could adversely affect valve performance require qualification tests to be repeated using the number of samples quoted in Table 1.

NOTE — Reduced number of samples may be taken, depending upon the change in consultation with the inspection authority.

8.3 These changes can involve, but are not limited to modifications to the valve components (for example O-ring, packing, spindle, suitable lubricant, material for valve body or characteristics changes affecting flow path, inlet size or internal components). Relevant tests only to be done if any change is carried out – examples below.

a) *Increase of valve working pressure* — repeat of valve burst pressure test, endurance test followed leak tightness test and oxygen pressure surge test (if applicable);
b) *Changes of the valve body material* — repetition of any tests to be decided case by case depending on changes of the chemical composition and mechanical properties in consultation with the statutory inspection;

NOTE — It is recognized that change in chemical composition of valve body material from one grade of brass to another grade of brass will not require repeat of the endurance and oxygen pressure surge test.

c) *Changes of the hand wheel material* — repetition of the excessive torque tests and flame impingement tests;
d) *Changes of the hand wheel diameter* — repetition of the endurance test followed by leak tightness test and excessive torque test;
e) Changes of the basic design dimensions of the valve components (for example, bottom spindle diameter, spindle thread pitch, seat diameter, dimensions of the O-ring(s), diaphragm thickness and flow path) — repetition of tests to be decided case by case depending on the change and in consultation with the statutory authority;
f) Changes in material of valve internal or external sealing system (for example, change in one type of non-metallic seal to another type of non-metallic seal) – repetition of endurance test;
g) Changes of metallic material of the valve operating mechanism components (for example, gland nut, spindle, springs) – repetition of tests to be decided case by case depending on the change;
h) Variation to outlet connection do not require further type testing; and
j) Addition to inlet connection — repetition of valve impact test and valving torque test.

8.4 Drawing

Assembly drawing for a valve design shall include the following details:

a) Part list and material specification;
b) Variants within a valve design;
c) Gas service and corresponding valve working pressure (P_w);
d) Lubricants, if used in the valve;
e) Inlet sizes;
f) Outlet sizes; and
g) Minimum closing torque (T_c);

8.5 Test Pressure

8.5.1 *Valve Burst Test Pressure (P_{vbt})*

$$P_{vbt} = 1.5 \times 1.5\ P_w$$

8.5.2 *Valve Test Pressure*

$$P_{vt} = 1.2 \times P_w$$

8.6 Mechanical Strength

8.6.1 *Valve Burst Pressure Test*

One sample shall be tested. The burst pressure test shall be carried out consecutively on the same test sample in the following order.

a) The valve seat in closed position (valve outlet connection is opened); and
b) The valve seat in open position (valve outlet

Table 1 Test Schedule for Type Testing (No Variants)
(*Clauses* 5.6.1, 5.6.2, 8.1, 8.2, 8.7.1 *and* 9.6)

Sl No.	Test Schedule	Test and Relevant Sub clause	Condition of Test Sample	Test Temperature °C	Test Pressure Bar	Test Sample Number	Number of Tests per Sample	Total Number of Tests
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	1	Valve burst pressure **8.6.1**	As received	Room temperature	P_{vbt}	1	2	2
ii)	2	Excessive torque **8.6.4**	As received	Room temperature	—	7 to 10	1	4
iii)	3	Internal / External leak tightness **8.7**	As received	Room temperature	*See* Table 3	2 to 6	6	30
iv)	4	Endurance **8.8**	From test 3	Room temperature	P_{vt}	2 to 6	1	5
v)	5	Internal / External leak tightness **8.8**	From test 4	Room temperature	*See* Table 3	2 to 6	6	30
vi)	6	Internal / External leak tightness **8.7**	From test 5	$-20^{0/-5}$	*See* Table 3	2 to 6	6	30
vii)	7	Internal / External leak tightness **8.7**	From test 6	65±2.5	*See* Table 3	2 to 6	6	30
viii)	8	Visual examination **8.9**	From test 7	Room temperature	—	2 to 6	1	5
ix)	9	Flame Impingement **8.10**	As received	Room temperature	—	11	1	1
				Mechanical Test				
x)	10	Valve impact test, **8.6.2**	As received	Room temperature	—	As marked	One from each category covered in the drawing	As applicable
xi)	11	Valve torque test, **8.6.3**						

NOTE — For additional material variants, test sample numbers and number of tests will change.

connection(s) closed. Valves equipped with actuator shall be opened according to manufacturer's specification.

Water or another suitable liquid shall be used as test medium. The hydraulic pressure shall be applied via the inlet connection and be raised continuously and gradually until at least P_{vbt} is reached. The pressure shall be maintained for at least 2 min.

The test sample shall withstand the test without permanent visual deformation or burst.

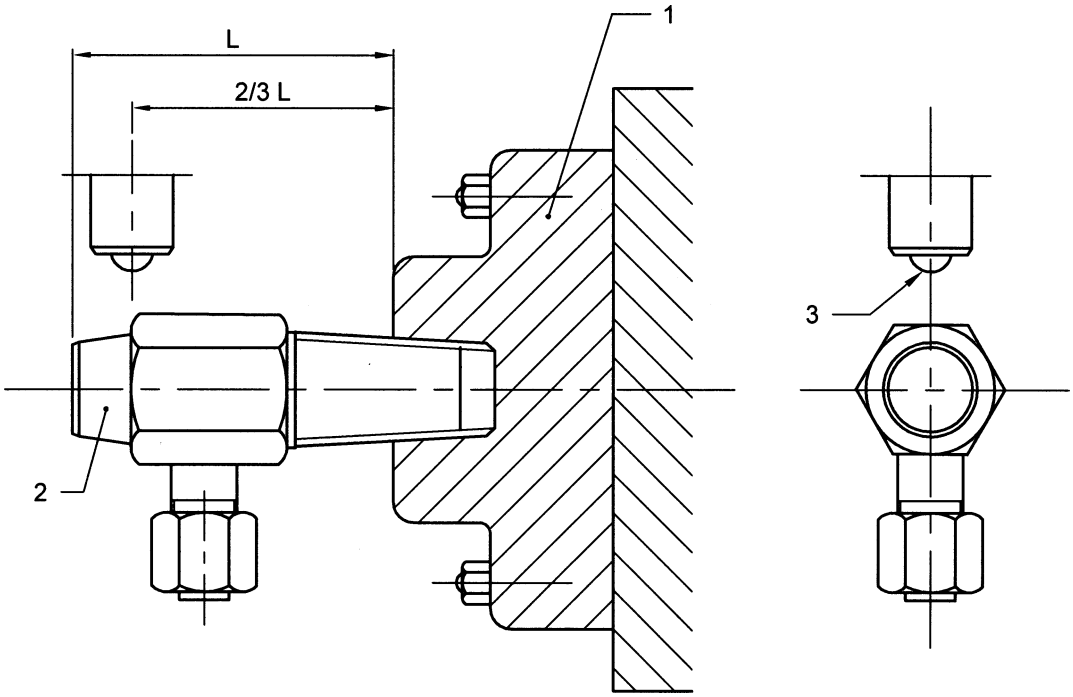
NOTE — For the test in closed position it is permissible for the valve to leak through the seat at a pressure above P_{vt} but below P_{vbt} provided no parts are ejected.

8.6.2 *Resistance to Mechanical Impact* (*Valve Impact Test*)

The purpose of this test is to ensure that the valve has sufficient strength to withstand impact during transport without release of gas contents.

For taper threads the test sample shall be fitted using the minimum of all given torque values for the tested inlet connection (*see* Table 2A) or the minimum torque value specified by the valve manufacturer. For parallel threads the test sample shall be fitted using the maximum of all given torque values for the tested inlet connection (*see* Table 2B) or the maximum torque value specified by the valve manufacturer.

A hardened steel weight incorporating hardened steel ball of 13 mm diameter (a typical test rig shown in Fig. 13) shall be dropped through a height so as to deliver impact energy of 120 J at a minimum velocity of 3 m/s. This shall be achieved by allowing the weight to fall vertically.



KEY

1 Test Block Manufactured from Which Simulates Cylinder Neck or Cylinder
2 Valve Body
3 13 mm Diameter Hardened Steel Ball

FIG. 13 IMPACT TEST

The impact shall be in such a position that the blow from a 13 mm diameter steel ball is normal to the centerline of the valve and not cushioned by protrusions such as outlet connection thread.

The point of impact shall be approximately 2/3 of the distance between the first exposed stem thread and the top of the valve body measured along the longitudinal axis of the valve.

The valve shall be struck once only and shall withstand the impact energy of 120 J, distortion due to impact is permissible.

The valve shall not crack or shear. In addition the test sample shall remain operable by wheel/knobs.

8.6.3 *Valving Torque Test*

The test sample shall be tightened using compatible thread sealant/o-ring as applicable. Table 2A gives the values of recommended valving torque for valves with taper stems and Table 2B gives the values of recommended valving torque for valves with parallel threads. Test sample shall be subjected to over torque value that is 50 percent in excess of the maximum torque value given in Table 2A and Table 2B. There shall be no sign of cracking or permanent deformation of the valve body or cracking of the valve stem. Deformation of the valve stem thread is acceptable.

Table 2 A Recommended Valving Torque for Taper Threaded Valve Stem
(*Clauses* 8.6.2 *and* 8.6.3)

Valve Material	Category	Inlet Thread Code	Valving Torque Seamless Steel Cylinders up to 300 Bar	
			Minimum Nm	Maximum Nm
(1)	(2)	(3)	(4)	(5)
Copper base alloy and Carbon steel	I	18T 08N 17E 25.4	120	150
	II	12N 25E	200	300

NOTE — The torque figures given above are for use with PTFE thread sealant. If different sealant or pressure ranges are introduced, the torque figures given in the table may have to be changed to ensure a gas tight joint.

Table 2B Recommended Valving Torque for Parallel Threaded Valve Stem for Aluminium Cylinder (Type 1, Type 2, Type 3)
(*Clauses* 8.6.2 *and* 8.6.3)

Valve Material	Category	Inlet Thread Code	Valving Torque – Nm	
			Minimum	Maximum
(1)	(2)	(3)	(4)	(5)
Copper base alloy, Carbon steel and Stainless steel	I	18P	85	90
	II	25P	95	130

8.6.4 *Excessive Torque Test*

Four samples shall be used for this test. The purpose of this test is to check that the valve operating mechanism has adequate strength, and fails safely if subjected to excessive torque.

A closing torque on one test sample shall gradually be increased to T_o according to Table 4. At T_o the valve shall be able to work without noticeable difficulties. It shall not show any damage or failure of any component of the valve operating mechanism and/or valve operating device. This shall be checked by visual examination after dismantling the valve.

To determine T_f closing torque on a different test sample than used for the determination of T_f shall gradually be increased slowly until failure of any part of the valve operating mechanism or valve operating device occurs. After this test, the valve operating mechanism may be severely damaged and not operable. Mechanical failure shall be in a manner that will not result in ejection of valve components. This shall be checked by visual examination.

This test shall then be repeated on two other test samples under the same conditions, but applying an opening torque instead of a closing torque.

The value of T_f determined from applying a closing and an opening torque shall be not less than the value given in Table 4.

8.7 Leak Tightness Test

8.7.1 *General*

Minimum of five samples will be tested. Additional samples may be required to cover more than two variants within a valve family.

Table 3 Test Pressures for Leak Tightness Test
(*Clauses* 5.6.1, 5.6.2, 8.7.1, 8.7.2.2, 8.7.3 8.8.1 and *Table* 1)

0.5 bar
9 bar
P_{vt}

Each internal and external leak tightness test temperature sequence (*see* Table 1) shall conform the test pressures as given in Table 3 in increasing order for room and high temperature and decreasing order for -20° C test.

NOTE — The order is chosen to reflect normal cylinder operations.

Prior to the test the valves shall achieve the relevant test temperature as given in Table 1 and shall be maintained at that temperature throughout the complete test procedure. After the valves are tested at low temperatures allow the test samples to naturally come to room temperature before applying high temperature to avoid temperature shocks between tests.

8.7.2 *Internal Leak Tightness Test*

8.7.2.1 The test shall be carried out in the following order:

a) Seal valve outlet connection(s);
b) Open the valve;
c) The pressure shall be applied to the valve inlet and be raised until the test pressure is reached;
d) Close the valve to the closing torque. For the leak tightness test carried out before the endurance test, the closing torque is T_c. For the leak tightness test carried out after the endurance test, the closing torque required to achieve tightness shall not be greater than $T_{e,end}$;
e) Open the valve outlet connection; and
f) Wait at least 1 min before measuring the seat leakage rate.

8.7.2.2 The internal leakage rate shall not exceed the rate specified in **5.6.1**. This test sequence shall be repeated for each test pressure given in Table 3. Before applying the next test pressure it is allowed to vent the cylinder valve.

8.7.3 *External Leak Tightness Test*

The test shall be carried out in the following order:

a) Seal valve outlet connection(s);
b) Fully open the valve;
c) The pressure shall be applied to the valve inlet and be raised until the test pressure is reached;
d) Wait at least 1 min before measuring the total leakage rate;

e) In addition, except for diaphragm gland seal valve, the leakage rate shall be determined with the valve operating mechanism in two intermediate positions (for example approximately two-thirds and one-thirds of the 'fully open' position; and

f) Wait at least 1 min before measuring the seal leakage rate.

NOTE — Some valve designs require extended time before measuring the leak due to trapped air in the non gas wetted area.

The external leakage rate shall not exceed the rate specified in **5.6.2**. This test sequence shall be repeated for each test pressure given in Table 3. Before applying the next test pressure it is allowed to vent the cylinder valve.

8.8 Endurance Test

8.8.1 *General*

Samples subjected to leak tightness test (*see* **8.7**) shall be used for endurance test.

An endurance test of 2 000 cycles (opening and closing) shall be carried out using T_e as given in Table 4 at P_{vt}. The valve inlet shall remain pressurized to P_{vt} throughout the test. The valve outlet shall be connected to a venting device that remains closed during the closing and opening position of the cycle. After each closure, by opening the venting device, the pressure downstream of the valve seat shall be released to atmosphere to reach atmospheric pressure.

The valve may be tested with or without the hand wheel. Valve design which requires special operation of the hand wheel to engage with the valve operating mechanism, for example, valves with hand wheels that incorporate a push to turn locking mechanism. With such valves it is permissible to override this mechanism during the endurance test.

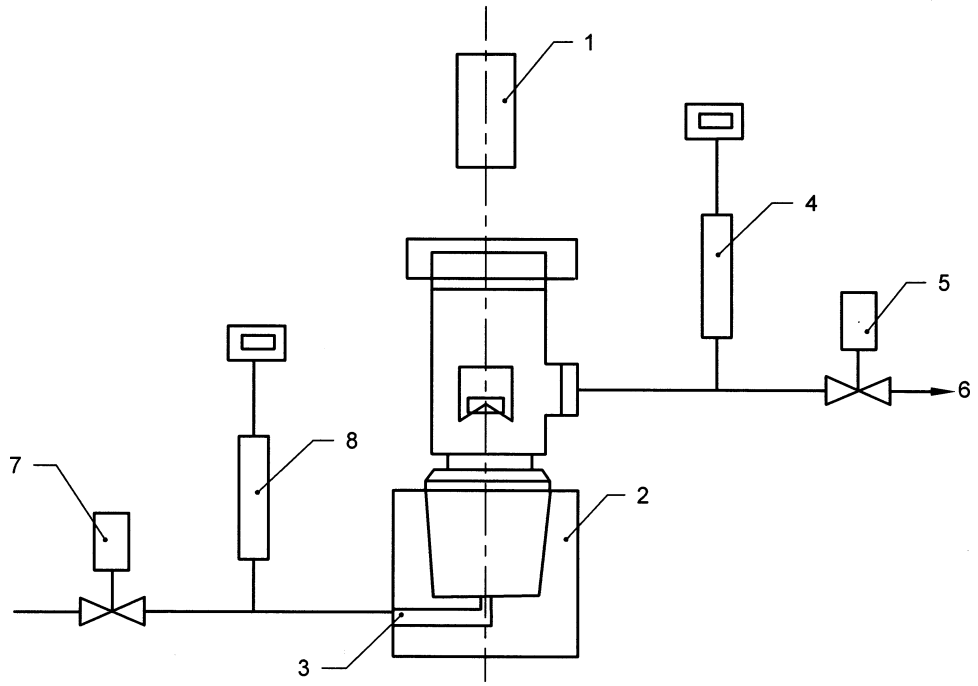
T_e and the leakage (by pressure drop) shall be established immediately before commencing every cycle. In case the pressure drop due to the valve leaking externally is greater than 10 bar, the valve has failed the test.

There shall be pause of at least 6 s at each open and fully closed position. In Fig. 3 it is once.

The test shall be performed between 1 to 3 cycle per minute.

After completion of 2 000 cycles, test samples will be tested for leak tightness test (*see* **8.7**) at room temperature, -20° C and 65° C at specified pressures given in Table 3 and T_e shall not be exceeded.

8.8.2 *Typical Arrangement of Endurance Test Equipment*



KEY
1) D.C. motor with torque transmitter 6) Outle
2) Test sample with adapter 7) Valve
3) Input test medium 8) Inlet high pressure transducer with disply for monitoring of *P*vt.
4) High pressure transducer with disply a) In closed position : From *P*vt to atmospheric pressure. In open position *P*vt
5) Venting valve b) In closed position ; Sequence closed / open / closed. In open position : closed

FIG. 14 TYPICAL ARRANGEMENT OF COMPUTER CONTROLLED TEST EQUIPMENT

8.8.2.1 *Requirements of machine and test cycle*

a) *Speed and Application of Torque* — The test machine shall be able to open and close the test sample at a speed of between ten and thirty rotations per minute.

At the end of the closing part of the test cycle, drift in torque due to dynamic effects shall be not more than 9 percent of the set value.

b) *Alignment* — The test sample and the test machine spindles shall be aligned in such a way that no significant side or axial load is put on the valve during the test.

c) *Verification* — Verification of the machine with regard to all test parameters to be controlled and measured such as torque and pressure shall be carried out before commencing and after completion of each endurance test.

d) *Stroke of the Endurance Test* — The test sample shall be cycled through its full stroke except that the value rotation shall be stopped 45° to 90° before the fully open position. This will ensure that the test machine does not apply torque in the fully open position. This shall not be applicable for ball valves in which case the ball valve will be turned from full close to full open position.

e) *Record* — The test cycle shall be recorded automatically (for example as an illustration, *see* Fig. 15).

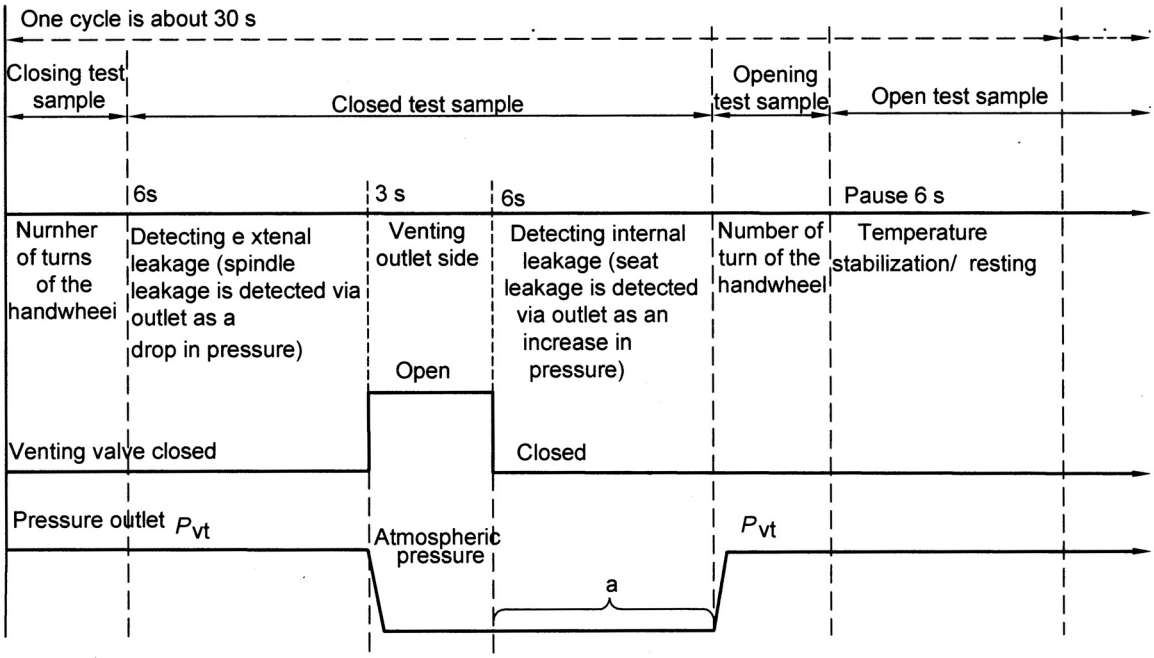


FIG. 15 DIAGRAM SHOWING A TYPICAL CYCLE FOR THE ENDURANCE TEST

Table 4 Torques to be Used for the Endurance Test and Excessive Torque Tests
(*Clauses* 5.3.1, 5.3.2, 8.6.4 *and* 8.8.1)

Sl No.	Valve Design as Given in 4.1	Valve Seal/Seat	Valve operating Device	Endurance Torque T_e (with a Relative Tolerance of $^{+9}_{-0}$%)	Over Torque T_o	Failure Torque T_f
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	O-ring gland seal valve	Nonmetallic	Hand wheel diameter D = 65 mm	7 Nm	20 Nm	25 Nm
ii)	Pressure seal valve and ball valve		Hand wheel of other diameter	D × 7/65 Nm	D × 20/65 Nm	1.25 × T_o

8.9 Visual Examinations

When the endurance test and the subsequent leak tightness tests have been completed, components such as diaphragms, hand wheel and hand wheel to spindle interface, bellows and O-rings shall be subjected to a visual examination. No components shall be displaced due to testing, non-functional (for example broken) or missing. No sealing interface degradation such as tearing, ripping and particle accumulation (particle collected or produced at that point) shall be evident for metal to metal seated cylinder valves for oxygen service. During the visual examination verification that the valve and its components correspond to the approved drawing shall be carried out.

8.10 Flame Impingement Test

One test sample shall be tested. The valve operating device of the test sample in the open position shall be exposed for 1 min ± 5s to an LPG blowpipe flame of 150 mm length, such that the flame reaches a typical temperature of between 800° C and 900° C. The valve operating device shall be completely enveloped by the flame.

Although the valve operating device may be damaged during the test, a manually operated valve shall still be possible to be closed by hand or using a simple tool after cooling. For other than manually operated valves it shall be verified that either the operating mechanism is still functioning (open/close) or that the valve is in the closed position.

NOTE — The temperature of the operating device exposed to the flame may be less than the temperature of the flame and need not be measured.

9 PRODUCTION INSPECTION AND TESTING

9.1 Tensile Strength and Elongation Test

Samples from each batch of valve bodies as per Table 5A shall be subjected to the test for tensile and elongation of the material of the valve body for meeting the requirements as per **4.2.1** and the lot shall be declared satisfactory with respect to the requirement of tensile and elongation test if each sample passes the test satisfactorily.

9.2 Izod Impact test

Samples from each batch of valve bodies as per Table 5A shall be subjected to the impact test (Izod impact strength) for meeting the requirements as per **4.2.2** and the lot/batch shall be declared satisfactory with respect to the requirement of Izod impact test if each sample passes the test satisfactorily.

9.3 Internal and External Tightness Test

All valves shall be tested for external and internal leakage by air or nitrogen at room temperature at working pressure (P_w). Valves shall be closed at T_c specified by the manufacturer but not exceeding $T_{e,}$ start. The internal and external leakage shall not exceed 6 cm^3 /h. Closing torque will not exceed T_e start during internal leakage testing.

9.4 Checking of Inlet Connection

Samples from each batch of valves as per the scale of sampling given in Table 5B will be checked for inlet dimension. The threads shall be checked by calibrated ring gauges.

9.5 Checking of Outlet Connection

Samples from each batch of valves as per the scale of sampling given in Table 5B will be checked for outlet dimensions. The threads shall be checked by calibrated gauges and other dimensions by vernier caliper or suitable measuring device.

9.6 Checking of Other Dimensions

Samples from each batch of valves as per scale of sampling given in Table 5A will be checked. For key operated valves, square of the spindle and for Pin-index Valves the width of the spindle shall be checked as per requirement of Table 1.

9.7 Scale of Sampling

9.7.1 Quantity of valve body blanks manufactured from same material and size manufactured under similar processes of production shall constitute a lot/batch.

9.7.2 The number of valve bodies/valves to be selected at random from a lot/batch shall depend upon the size of the lot/batch and shall be in accordance with respective tables for identified inspection/tests.

9.7.3 The lot/batch shall be declared satisfactory with respect to the requirement of the given test if each sample as per the scale of sampling passes the test satisfactorily. If any test sample, tested to tensile and elongation (*see* **4.2.1**) and Izod impact test (*see* **4.2.2**), fails to meet the specified requirements therein, additional specimens equalling twice the number of sample size for the failed test in the same lot/batch shall be taken and tested for the failed test only. If any of these specimens fails to meet the requirement, the entire lot/batch represented shall be rejected.

Table 5A Scale of Sampling
(*Clauses* 9.1, 9. 2 *and* 9.6)

Sl No.	Lot / Batch Size	Sample Size
(1)	(2)	(3)
i)	Up to 500	2
ii)	501 up to 900	4
iii)	901 up to 2 000	6
iv)	2 001 to 3 000	8

Table 5B Scale of Sampling
(*Clauses* 9.4 *and* 9.5)

Sl No.	Lot / Batch Size	Sample Size
(1)	(2)	(3)
i)	Up to 500	10
ii)	501 up to 1 000	15
iii)	1 001 up to 2 000	20
iv)	2 001 up to 3 000	25

10 MARKING

10.1 Cylinder valves complying with this standard shall be durably and legibly marked in service with:

a) Year and month of manufacture, that is YYYY/MM;
b) Valve Lot/Batch identification;
c) Chemical symbol of the gas;
d) Manufacturer's identification;
e) IS 7302;
f) Working pressure of the valve; and
g) Inlet thread code (*see* Annex A).

10.2 BIS Certification Marking

Each valve may also be marked with the Standard Mark.

10.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a license for the use of the Standard Mark maybe granted to the manufacturers or the producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clause* 10.1 (g))

THREAD CODE FOR INLET CONNECTION

Taper Thread Inlet

Code	*Thread Designation*	*Inlet Type*
08N	½ - 14 NGT (1:16)	Type 1 (Size 1)
12N	¾ - 14NGT (1:16)	Type 1 (Size 2)
17E	19.8 (3:25)	Type 2 (Size 1)
25E	28.8 (3:25)	Type 2 (Size 2)
18T	18.16 (1:8)	Type 4 (Size 1)
25.4	25.40 (1:8)	Type 4 (Size 2)

Parallel Thread Inlet

Code	*Thread Designation*
18P	M18 × 1.5 P-6g
25P	M25 × 2 P-6g

ANNEX B

(Foreword)

COMMITTEE COMPOSITION

Gas Cylinders Sectional Committee, MED 16

Organization	*Representative (s)*
Petroleum and Explosive Safety Organization, Nagpur	Dr Sudarshan Kamal (***Chairman***) Shri Ashendra Singh (*Alternate*)
All India Industrial Gases Manufacturers Association, New Delhi	Shri Saket Tiku Shrimati Veena Peter (*Alternate*)
Ashok Leyland Limited, Chennai	Shri M. Ravi Shri S. Arun (*Alternate*)
Bharat Petroleum Corporation Ltd, Mumbai	Shri. S. Sriram Shri A. Prabhakar (*Alternate*)
Bharat Pumps and Compressors Ltd, Allahabad	Shri Mohan Kumar Shri P. G. Choudhury (*Alternate*)
Bhiwadi Cylinders Pvt Ltd , New Delhi	Shri Manvinder Singh Shri Rajneesh Chopra (*Alternate*)
Everest Kanto Cylinder Ltd, Mumbai	Shri P. M. Samvatsar Shri A. K. Khamkar (*Alternate* 1) Shri H. D. KhaTRI (*Alternate* 2)
GSPC Gas Co Ltd, Ahmedabad	Shri K. S. R. Prasad
Hindustan Petroleum Corporation Ltd, Mumbai	Shri Alok K. Gupta Shri P. N. Kanth (*Alternate*)
Indian Oil Corporation Ltd, Mumbai	Shri Ashutosh Tiwari Shri S. M. Rambhal (*Alternate*)
Indraprastha Gas Limited, Delhi	Shri Praveen K. Pandey Shri Alok Sharma (*Alternate*)
International Industrial Gases Ltd, Kolkata	Shri Devendra K. Garg Shri Nikhilesh K. Garg (*Alternate*)
Inox India Limited, Vadodara	Shri Deepak V. Patwardhan Shri Deepak V. Acharya (*Alternate*)
Kabsons Gas Equipments Ltd, Hyderabad	Shri Satish Kabra Shri. S. Gopalaiah (*Alternate*)
Kosan Industries Ltd, Mumbai/Surat	Shri Sunil K. Dey Shri S. B. Bolmal (*Alternate*)
LINDE India Ltd, Kolkata	Shri Ramana Vutukuru Shri Pradeep (*Alternate*)
LPG Equipment Research Centre, Bangalore	Shri P. Krishnan Kutty Dr. A. Krishna (*Alternate*)
Mahanagar Gas Limited, Mumbai	Shri S. Murali Shri Arun Nayak (*Alternate*)
Maruti Koatsu Cylinders Ltd, Mumbai	Shri Nitin J. Thakkar Shri A. S. Saran (*Alternate*)
Organization	*Representative (s)*
Ministry of Defence (DGQA), Pune	Shri J. P. Tiwari Shri K. Sudhakaran (*Alternate*)
Research & Development Estt (Engineers), Pune	Shri P. K. Chattopadhyay Shri A. Basu (*Alternate*)
SICGIL India Ltd, Chennai	Shri S. Maragathavel Shri Nauzer Dadabhoy (*Alternate*)
Society of Indian Automobile Manufacturers (SIAM), New Delhi	Shri K. K. Gandhi Shri Pankaj K. Karn (*Alternate*)

Steel Authority of India Ltd, Ranchi	Shri Debashis Karmakar Dr Anjana Deva (*Alternate*)
Supreme Cylinders Ltd, Delhi	Shri M. L. Fathepuria
Tata Motors Ltd, Pune	Shri P. K. Banerjee Shri Amul Verma (*Alternate*)
Tekno Valves, Kolkata	Shri Y. K. Behani Shri R. Behani (*Alternate*)
The Automotive Research Association of India, Pune	Dr S. S. Thipse Shri S. D. Rairikar (*Alternate*)
Trans Valves (India) Pvt Ltd, Hyderabad	Shri A. K. Jain Shri P. K. Mathur (*Alternate*)
Vanaz Engineers Ltd, Pune	Shri S. J. Vispute Shri A.V Kulkarni (*Alternate*)
BIS Directorate General	Shri T. V. Singh, Scientist 'F' and Head (Med) [Representing Director General (*Ex-officio*)]

Member Secretary
Shri Chandan Gupta
Scientist 'B' (MED), BIS

Gas Cylinder Valves and Fittings Subcommittee, MED 16:1

Organization	*Representative(S)*
Tekno Valves, Kolkata	Shri Y. K. Behani (***Convener***) Shri R. Behani (*Alternate*)
All India Gases Manufacturers Association, Vadodara	Shri Saket Tiku Shrimati Veena Peter (*Alternate*)
Batra Associates Limited, Faridabad	Shri N.K. Sawhney
Bharat Petroleum Corporation Ltd, Mumbai	Shri S. Sriram Shri A. Prabhakar (*Alternate*)
Everest Kanto Cylinder Ltd, Mumbai	Shri P. M. SAMVATSAR Shri A. K. KHAMKAR (*Alternate* 1) Shri H. D. KHATRI (*Alternate* 2)
Hindustan Petroleum Corporation Ltd, Mumbai	Shri Alok Kumar Gupta Shri S. Nandi (*Alternate* 1) Shri P. N. Kanth (*Alternate* 2)
Indian Oil Corporation Ltd, Mumbai	Shri Ashutosh Tiwari Shri S. M. Rambhal (*Alternate*)
Jai Gopal Engineering. Works Pvt.Ltd; New Delhi	Shri Jai Gopal Mehta Shri A.K. Gupta (*Alternate*)
Kabsons Gas Equipments Ltd, Hyderabad	Shri Satish Kabra Shri KUNAL Kabra (*Alternate*)
Kosan Industries Ltd, Mumbai	Shri S. K. Dey Shri S. B. Bolmal (*Alternate*)
LPG Equipment Research Centre, Bangalore	Shri P. Krishnan Kutty Dr A. Krishna (*Alternate*)
Petroleum and Explosive Safety Organization, Nagpur	Shri Ashendra Singh
Southern Metals and Alloys Pvt Ltd, Mumbai	Shri Vivek Noronha Shri Vinod Noronha (*Alternate*)
Trans Valves (India) Pvt Ltd, Hyderabad	Shri A. K. Jain Shri P. K. Mathor (*Alternate*)
Vanaz Engineers Ltd, Pune	Shri S. J. Vispute Shri A.V. Kulkarni (*Alternate*)

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

This Indian Standard has been developed from Doc No.: MED 16 (1382).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.org.in

Regional Offices: *Telephones*

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002 — 2323 7617, 2323 3841

Eastern : 1/14 C.I.T. Scheme VII M, V. I. P. Road, Kankurgachi, KOLKATA 700054 — 2337 8499, 2337 8561, 2337 8626, 2337 9120

Northern : Plot No. 4-A, Sector 27-B, Madhya Marg, CHANDIGARH 160019 — 26 50206, 265 0290

Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600113 — 2254 1216, 2254 1442, 2254 2519, 2254 2315

Western : Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400093 — 2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches: AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. DURGAPUR. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. JAMMU. JAMSHEDPUR. KOCHI. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAIPUR. RAJKOT. VISAKHAPATNAM.

Published by BIS, New Delhi